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EXPERIMENTAL STUDY OF PHOTO VOLTAIC SYSTEMS AND CONVERTERS

SIVA AGORA SAKTHIVEL MURUGAN K[1] & MOHAMMAD ABDUL BASEER[2]

[1]Assistant Professor, Department of Electrical Engineering, College of Engineering, Majmaah University, K. S. A

[2]Lecturer, Department of Electrical Engineering, College of Engineering, Majmaah University, K. S. A

ABSTRACT

The Power converters control the flow of power between two systems by changing the character of electrical energy: from direct current to alternating current, from one voltage level to another voltage, or in some other way. We will do starting with a look at the standards concerning grid connection of distributed resources, and its working way through how photo-voltaic cells workings, to how photo-voltaic modules with electrical converters can be arranged. Some different converter topologies suitable for use with photo-voltaic are found, and based on these topologies; solutions for how to control these converters have been examined. These control system involve the methods for utilizing the maximum power from the solar panels, methods for synchronizing with the grid and methods for current and voltage control.

This model is simulated in the Simulink and the experiments are made on a laboratory setup, where focus has been on the control system. Therefore the linear system models of the control system have been made, and these have formed a basis for the optimization of the control systems. The simulations have been made using the Simulinks, and the control systems for the converters have been implemented in two DSP's, one for each converter.

Most of the tests made in the simulations and the experiments have been made with the operating conditions close to the ideal. In order to verify how the system handles varying operating conditions, and to see if it coincides with the requirements in the standards, more extensive and effective testing should be made of the system.

KEYWORDS: Photo Voltaic Systems and Converters, Voltage Level to Another Voltage, Two DSP's, Simulink

INTRODUCTION

Today photo-voltaic and converters have become one of the major renewable energy sources in the world, and in order to utilize the energy from the power sources, the electrical converters are needed. This study is meant as an introduction to the design of *grid connected photo-voltaic electrical power converters*, and it has been written for the Department of the Electric Power Engineering at NTNU.

Power converters are electronic circuits associated to the conversion, control, and conditioning of electric power. The power range can be from milliwatts, mobile phone, for example, to megawatts, in electric power transmission systems. Reliability of the power converters become a key industrial focus. Electronic devices and the control circuits must be highly robust in order to achieve the highest useful life of the system. A special accent must be set for the total efficiency of the photo-voltaic system and power converters.

Firstly, because of the economic and the environmental value of wasted power and, secondly, because of the cost of energy dissipated that it may generate. Even a small improvement in converter power efficiency translates to improved profitability of the investment in the electronic market. For the medium power applications, the power converters with

bidirectional core excitation are preferred, because they utilize the magnetic components better. The push-pull, half-bridge and full-bridge converters are the examples of the latter.

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A much greater emphasis is required on achieving high-power efficiency in low-power level electronic technology, since few low-power circuits can tolerate power efficiency less than 85%. Converters are used in these circuits in order to change the supply voltage in the blocks of the System on Chips (SoCs) according to performance requirements, for power efficiency reasons.

The study would give an overview of the different aspects of designing the electrical converters. By taking the reader through the basics of what characterizes a photo-voltaic system and which requirements is put upon such a system, this report aims on giving a fundamental understanding of photo-voltaic power system and power converters. The theory will then be put to the test by finding a representative system model and then simulating it and test it on an experimental setup.

PROBLEM STATEMENT

The converter is meant to be used in the renewable energy laboratory at NTNU. It should be focused on the overall systems, and design should therefore be made with the basic solutions in order to make the complexity low. In order to make such design, a literature study giving an overview of the photo-voltaic systems and the power electronic converters used should be made. The study will focus on both the photo-voltaic system and power converters, but also the control of such systems. To verify the theoretical studies done in this thesis, the simulations and experimental tests of the system should be made.

OBJECTIVES

The objectives of the research thesis as follows:

- To work experimentally on the photo-voltaic systems and study its nature and behaviors
- To study about the electrical converters
- Experimentally review of photo-voltaic modules with electrical converters

PURPOSE OF STUDY

The purpose of this study is to work experimentally on the photo-voltaic systems and electrical converters to put the result of its working, behaviors, nature etc. and also simulation of the result would be done in this thesis.

RESEARCH HYPOTHESIS

Photo-voltaic modules working and nature with electrical converters could be much different as compared to normal conditions.

SIGNIFICANT OF STUDY

This experimental study signifies that the uses of Photo-voltaic modules with electrical converters. So this study would evaluate the working, nature and behaviors of the photo-voltaic systems.

NEED OF STUDY

As per the topic suggests that we would do experiments, tests and simulate the photo-voltaic system with electrical converter what would be most important for this system.

SCOPE OF STUDY

After studying this thesis and research findings we would be able to determine the natures of the photo-voltaic system with electrical converters. Hence this thesis could have a wider scope in future.

RESEARCH METHODOLOGY

A lot of research has recently been focused on converters due to the increasing deal of interest in power electronics. This is mainly caused by the broad applicability domain that includes the battery-operating portable equipment, computers, appliances, vehicles, industrial electronic equipment, uninterruptible power supplies, telecommunication systems and much more. The current topic suggests that the methods for this thesis should be experiments on photo-voltaic systems and electrical power converters. The second part of the thesis is focused on converters employed in low-power applications. As mentioned, the demand for high efficiency of the converters is increasing dramatically, especially in battery-operated devices such as cellular phones and personal computers.

Experiments and Analysis

The experiments would be done in this thesis and an analysis on the result would evaluate the objective and purpose of the study.

CONCLUSIONS

The controller achieves almost of the control requirements for SoCs technology. Nevertheless, parameter uncertainties and delays have been disregarded. The model is designed with the focus on testing of the theoretical models derived for the control systems of Photo-voltaic system and power converters, and with low focus on hardware efficiency.

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